

Abstract Submitted
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Nano-helix based quantum transistor, charge pump and motor¹

XIAOLIANG QI, SHOUCHEG ZHANG, Stanford University — We propose several novel device concepts based on nano-scale helical wires. Applying a static electric field transverse to the helical wire induces a metal to insulator transition, enabling the construction of a new type of transistor switch. The band gap is purely determined by the applied transverse voltage, and can be continuously tuned. The resulting light-emitting-diode can emit light with a tunable color spectrum. With a quadrupolar electrode configuration, the electric field could rotate in the transverse plane, leading to a quantized dc charge current proportional to the frequency of the rotation. Such a device could be used as a new standard for the high precision measurement of the electric current. The inverse effect implies that passing an electric current through the helical wire in the presence of a transverse static electric field leads to a mechanical rotation of the helix. This effect can be used to construct nano-scale electro-mechanical motors. Finally, our methodology also enables new ways of controlling and measuring the electronic properties of helical biological molecules such as the DNA.

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